USING RADIATION IN CANCER CARE

There are two major uses of ionizing radiation in the diagnosis and treatment of cancer:

Radiotherapy

Radiotherapy, or radiation therapy, uses high-energy radiation to control and eliminate cancer.

Radiology

Radiology largely uses lower-energy radiation to image tissues to diagnose disease or treat disease via the minimally invasive techniques used in interventional radiology.

Radiotherapy

Radiotherapy is the use of high-energy rays (e.g., gamma rays and X-rays) or particles (e.g., electrons, protons, and carbon nuclei) to control or eliminate cancer.

Radiotherapy works chiefly by damaging DNA, leading to cancer cell death with relative sparing of normal tissues.

Uses of Radiotherapy

- **Curative Radiotherapy** seeks to eliminate cancers, particularly small cancers and locally advanced cancers; it is often used in combination with systemic therapy.
- **Adjuvant Radiotherapy** seeks to eliminate any remaining cancer following prior treatment.
- **Neoadjuvant Radiotherapy** is used to shrink a cancer so that it can be subsequently treated by a different method such as surgery.
- **Palliative Radiotherapy** is used to reduce or control symptoms of disease when cure by another method is not possible.

Types of Radiotherapy

- **External Beam** radiotherapy, typically photons (X-rays) or electrons, delivers radiation to the tumor from outside the body; it is the most common form of radiotherapy.
  - Conventional (2-D) external beam radiation therapy delivers a high-energy X-ray beam from one or multiple directions. Imaging of the treatment area is typically performed using low-energy diagnostic X-rays. It is chiefly used in settings where high precision is not required, such as in the treatment of bone metastases.
  - 3-D conformational radiotherapy (3DCRT) uses specialized imaging, usually computed tomography (CT) and/or magnetic resonance imaging (MRI) and planning software to deliver high-energy X-rays via multiple beams that more precisely fit the shape and size of the tumor.
  - Intensity-modulated radiotherapy (IMRT) is a further refinement of 3DCRT that more precisely focuses and shapes the radiation by dividing each beam into many "beamlets," each of which can have a different intensity. IMRT is particularly useful when a sharp dose gradient is required between the tumor and sensitive tissues, for example, the optic nerves.
  - Intraoperative radiation therapy uses electron beam (superficial) radiation directly on tumors that have been exposed during surgical procedures.
  - Stereotactic radiotherapy is used in both stereotactic surgery (SRS) and stereotactic body radiotherapy (SBRT). It uses many (typically more than eight) beams with a highly sophisticated imaging system to direct radiation to very well-defined smaller tumors. Typically, SRS is used to treat tumors of the brain and central nervous system, whereas SBRT can be used on small tumors within larger organs of the body.
- **Particle Therapy** refers to protons or carbon ions rather than X-rays as the source of energy. In contrast to X-rays that pass though the body, losing energy and causing damage to the noncancerous tissues through which they pass, these heavier particles deposit most of their energy in the target. In this manner, particle therapy can deliver higher doses with less damage to surrounding tissue. Although of great interest, proton facilities are much more expensive than traditional facilities, and the overall benefit to selected patients is still being determined.
- **Brachytherapy** places small radioactive sources in or next to the tumor either temporarily or permanently.
- **Radioisotope Therapy** involves systemic ingestion or infusion of radioisotopes, for example, iodine-131 to treat thyroid cancer or lutetium-177 dotatate (Lutathera) to treat gastroenteropancreatic neuroendocrine tumors.